# Challenges to Bicycle Usage in Columbus, Ohio:
# A Seasonal Analysis of Central Ohio Greenway Mode Choice

Honors Thesis City & Regional Planning

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**Abstract**

In the United States, bicycle ridership is generally lower than in other cities across the globe. American cities lag behind other countries, especially some cities in Western Europe such as Copenhagen and Amsterdam. A number of factors may contribute to this decrease in ridership such as reduced infrastructure and a lack of cycling culture. Another factor may be weather, which is a focus of this study. How does weather impact ridership in U.S. cities, and what can those cities do about it? To explore this question, I measure how temperature and precipitation impact trail use and cycling in Columbus, Ohio. During the winter months between December 21, 2020 and March 20, 2021, I collected original broad data on trail usage modeled after a study conducted by the Mid-Ohio Regional Planning Commission. Two North American case studies were also done on Portland, Oregon and Montréal, Canada in order to understand how higher ridership is maintained with adverse weather conditions. I argue that there is a greater potential for usage in Columbus. Of the total number of users observed on the trails, 18% were bicyclists and 77% were pedestrians. Temperature and precipitation also played key roles. As temperature increased, bicycle ridership increased. Similarly, on days with little or no precipitation, ridership was higher than days with heavier rainfall or snow. Columbus is projected to continue growing in the long-term, and investing in a more interconnected, well-maintained, and widely accessible bike network has the potential to create cultural change in the city for bicycles that would significantly change mode choice for those living in the region.

## Chapter 1: Introduction

Established in 1812, Columbus geographically sits at the center of Ohio and at the heart of the Midwest. With a population close to 900,000 based on 2019 estimates, Columbus is not only the largest city within Ohio, but it is the 14$^{th}$ largest city in the United States (Millsap; U.S.

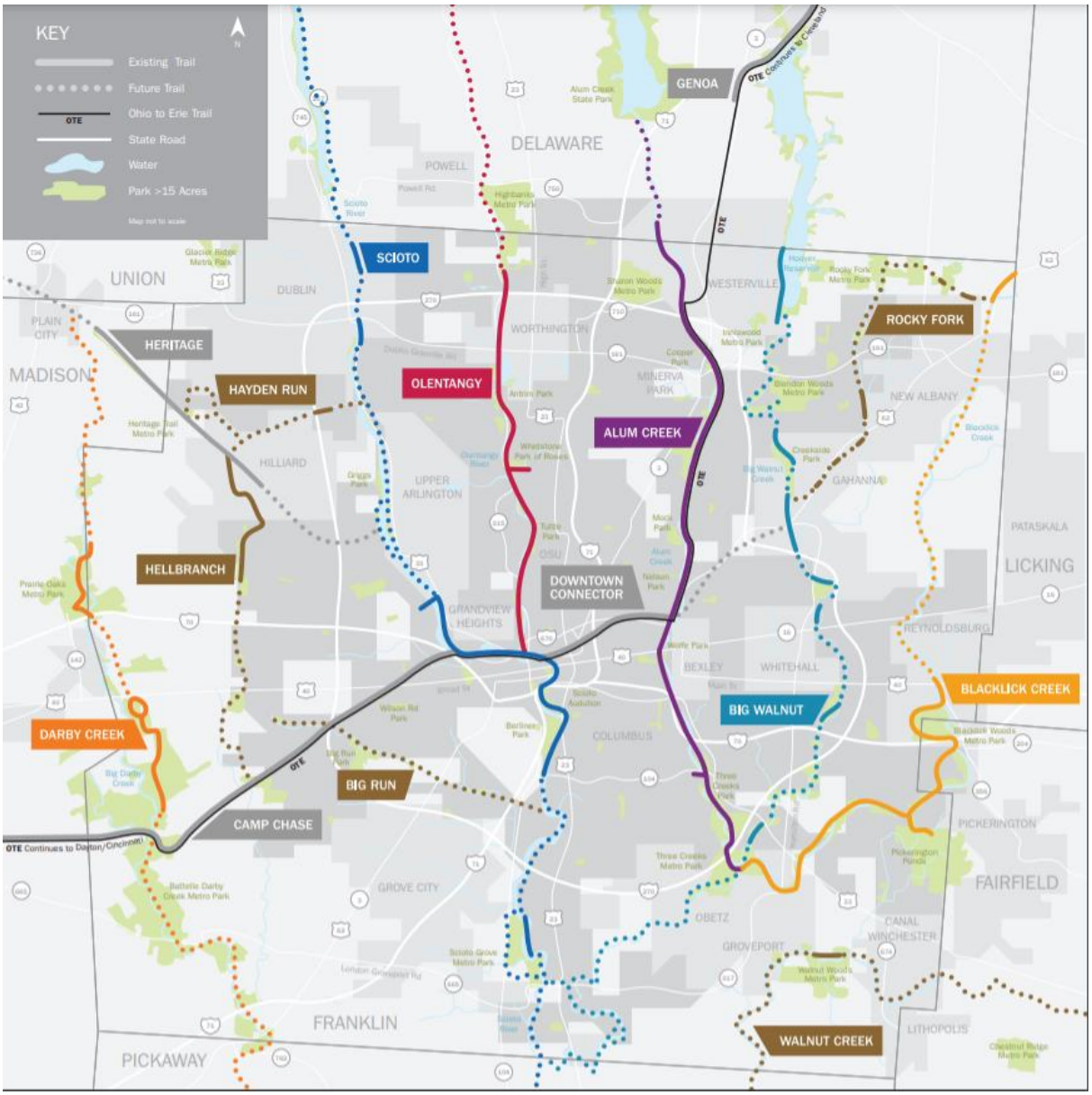
Census Bureau). In fact, the population has “exploded” , doubling from 1960 to 2017 (Millsap). Significant growth is on the horizon as Columbus is estimated to grow by up to a million people by the year 2050 (“Scenario Analysis”). Columbus has a plethora of attractive characteristics including an affordable cost of living, various historic neighborhoods, fascinating arts and sporting districts, and open, accepting cultural attitudes (Columbus Community Profile). Furthermore, Columbus boasts a large amount of green space with sprawling new developments like the 33-acre Scioto Greenways and extensive Metro Parks system. Columbus is a rapidly growing place with many lures that incentivize individuals to move to the city and act as excellent commodities to those living in the region.

The Metro Park system within central Ohio has a mission “to conserve open spaces, while providing places and opportunities that encourage people to discover and experience nature” (“About Us”). The system throughout Columbus includes 20 parks and 230 miles of trails to utilize. Established in 1945, the Metro Parks are open each day for public access. The Metro Parks maintain the Central Ohio Greenways, a collection of trails that span across the region.

Central Ohio Greenways is a network of trails throughout the central Ohio region that connect picnic areas, boating and fishing facilities, and a multitude of parks (“About-Central Ohio Greenways”). By definition, greenways are “strips of land set aside for recreational use and environmental protection” (“About-Central Ohio Greenways”). They are designated for recreation and transportation purposes for pedestrians and non-motorized vehicles (Gibson et al). There are over 230 miles of trails within the network (see Figure 1) on which over 12 million miles are traveled each year. The Central Ohio Greenways Board was formed as a committee within Mid-Ohio Regional Planning Commission, hereafter referred to as MORPC, with the

mission to “increase greenways trail mileages and use of trails for recreational and transportation needs” (About-Central Ohio Greenways).

*Figure 1: Central Ohio Greenways Map*




During the spring and fall of 2020, MORPC collected data on the mode choice of users on the Central Ohio Greenways trails. Volunteers traveled to 17 locations across Columbus and collected data on the trail users that passed a certain checkpoint during a two-hour block of time (“2020_Volunteer”). The Metro Parks have counting equipment that is set up along the trails;

however, the counts done by volunteers are higher than those collected by the systems. This result is likely due to an issue with the equipment being unable to identify when pairs of individuals are walking by or an inability to differentiate individuals within larger groups. This original study did not include data collection during the winter, which is the basis for this investigation. Due to this absence of data, a main question was developed that this research sought to address: How are the Central Ohio Greenways utilized during winter? An initial assumption was that overall trail usage would be much lower during the winter than trail usage during the fall and spring. A secondary question emerged over the course of this investigation; namely, how prevalent are bicycles during the winter as a transportation mode choice? This study served as a preliminary observation of the usage of the trails and mode choice by users during the winter.

Copenhagen, Denmark reigns as the most bicycle friendly city in the world. Copenhagenize, a design company that aids in the planning and design of bicycle infrastructure ("Our Work"), releases the Copenhagenize Index every two years which is "the most comprehensive and holistic ranking of bicycle-friendly cities on planet earth" (Wexler et al.). This Index has ranked Copenhagen as the #1 most bicycle friendly city in the world for years. Per day, approximately 1.44 million kilometers and 49% of trips to work/school are done on a bike (Thoem). James Thoem, a professional from Copenhagenize, writes, "But what is it about Copenageners that makes them take to the bicycle every morning come rain, sleet, or snow?...It comes down to three important factors: infrastructure, infrastructure, and infrastructure. Copenhagen has demonstrated that with a network of simple, safe, and connected infrastructure, the bicycle can be a competitive mode of transportation for people of all ages and abilities" (Thoem). This manifests by way of protected bicycle lanes, bike lanes on roads with traffic-

curbing measures, and off-street paths. The off-street paths are similar to some of the Central Ohio Greenways in that they run “through parks or along waterfronts, railway lines, and highways” (Thoem). Two such of Columbus’ paths run along the Scioto River and the Olentangy River. Further, consideration was given to connecting aspects of the city beyond the existing street grid. For example, the Quay Bridge, a connection over the harbor in Copenhagen, was estimated during the ideation stage to have 3,300 bicyclists a day. In 2018, after creation and opening, the bridge was serving over 20,000 cyclists every day, a major increase from the expected amount of users.

This high usage of bicycles in Copenhagen, no matter the season, is a testament to the infrastructure. In terms of weather, the average low during the cold months is 29° Fahrenheit with a high of 37° Fahrenheit (“WeatherSpark.com”). It rains all year in Copenhagen, but during the wettest season, which lasts 8 months, every day has a greater than 25% chance of rain. Copenhagen has inclement weather, nevertheless the city focuses on the bicycle infrastructure. During the cold seasons, the city salts the bike lanes before snow and then prioritizes the clearance of snow above the roads for cars (Jaffe).

Another city famously known for its bicycle-friendly nature in Western Europe that consistently tops the Copenhagenize Index is Amsterdam in the Netherlands. Positioned at #2 out of 20, Amsterdam has ranged throughout the top three cities of the Index since 2011 (“Amsterdam”). Of the three large categories of streetscape, culture, and ambition, Amsterdam scored a 3.7, 3.8, and 3.8 out of 4 respectively. Amsterdam has some of the most radical bicycle policies and infrastructure. In fact, the City has publicized a 2022 bicycle plan aimed at increasing bicycle parking and improving the infrastructure. Based upon a long-term plan from 2012-2016, the 2017-2022 Long-Term Bicycle Plan includes three major objectives:

1. “Smooth cycling: cyclists can reach their destination via wide, direct, fast, smooth, and recognizable routes
2. Easy parking: the Amsterdam cyclist can find a parking spot quickly and close to his or her destination – all without compromising on space for pedestrian. Our approach towards bicycle parking also considers parked mopeds and motorized bicycles
3. Better biking: As an international cycling city, Amsterdam has a very high reputation to maintain. We’ve made our name worldwide as a city that comprises ‘red’ and ‘green’ carpet cycle routes for cyclists. If we are to keep our good name, we should ensure that cyclists feel at ease. The goal is to increase the cycling satisfaction rating to 7.5 [out of 10] by 2025” (Litjens).

Amsterdam has approximately 835,000 residents, and the average number of bike rides is 665,000 each day. Per day, all of the bicycle trips combine for 2 million kilometers cycled per day. More than a third, 36%, of all trips made are done on a bicycle out of all modes of transportation. There are 400 kilometers of bicycle paths throughout the city (“Amsterdam’s”). This network began in the 1970s when there was a large investment in bicycle infrastructure. Cars were quite prevalent; however, 3,300 traffic casualties in 1971 spurred forward the movement for bicycles (van der Zee). In the 1980s, cities across the Netherlands began passing measures to create bicycle-friendly streets. Delft was the first city to institute a network of paths, and from there, other cities followed. This is evident in the fact that Amsterdam is not the only city from the Netherlands to be on the Copenhagenize Index. Utrecht is also ranked highly at #3 out of 20 (“Utrecht”). Now, 58% of Amsterdammers older than 12 cycle each day (“Amsterdam’s”). The bicycle has further taken hold with the Long-Term Bicycle Plan that outlined an effort to minimize car parking and maximize bicycle parking. There are over 10,000

bicycle parking spots, 25 bicycle parking garages, and between 200,000 and 225,000 bicycle racks ("Amsterdam's").

In terms of weather, the Netherlands is unpredictable ("The Weather and Climate"). Rainfall is common, with the Netherlands receiving near 79 cm (31.1 inches) of precipitation each year. For the winter, the average temperature in January is 35° Fahrenheit which is just above freezing. Even though Amsterdam may be flat and compact, with a maritime climate, the key to success for Amsterdam is not only the infrastructure, but also the will and desire to do more for bicyclists in the city.

American cities lag behind our peers in terms of cycling infrastructure. As the 2019 Copenhagenize Index shows, only 2 North American cities made the global top twenty (Wexler et al.). Within our cities, we still see interesting seasonal variation. Americans do not ride bikes as often when it is cold or wet out, but this does not need to be the standard (Nosal & Miranda-Moreno). Two of Western Europe's coldest and wettest countries, Denmark and the Netherlands, routinely top the list of global cities for cycling. Even the coldest country in Europe, Norway, has a city on the Copenhagenize Index (Wijnen; Wexler et al.). One of the United States' most notorious cities for rainy weather, Portland, Oregon, leads the way in terms of bicycle infrastructure and ridership. How does weather impact ridership in U.S. cities, and what can those cities do about it?

To explore this question, I measure how temperature and precipitation impact trail use and cycling in Columbus, Ohio, a city that is broadly representative of urban cycling trends in the U.S. Based on the American Community Survey 5-year estimate from 2013-2017, nationally, 0.6% of workers bike to work (Bureau). Similarly, in Columbus, based on data from the 2016 American Community Survey, 0.6% of people are bicycle commuters (League of American

Bicyclists). During the winter months between December 21, 2020 and March 20, 2021, I collected original broad data on trail usage, with a particular focus on cycling habits. My methodology mirrors a study conducted by central Ohio's regional metropolitan planning organization, MORPC, during the preceding spring and fall. I use this MORPC data as a baseline for comparing winter trends. My findings identify a clear correlation between temperature and trail usage. In order to identify strategies for U.S. communities like Columbus, I then turn to case studies of two North American cities that maintain high ridership despite adverse weather. Columbus, Ohio has an extensive network of well-maintained trails that are underutilized, and I argue that there is greater potential for their usage.

## Chapter 2: Literature Review

The wide-reaching nature of the Central Ohio Greenways has a major impact on the city and adds great value. A study published in 2015 detailed the impacts of central Ohio's trails (Lindsey, Greg, et al). Within the study, self-select surveys were distributed for individuals to take if they chose to. Approximately 40% of those who completed the survey indicated they had used trails to get to places such as the grocery store (Lindsey, Greg, et al). When asked about trail characteristics most important to the users, the participants indicated that trail surface, traffic safety, trail maintenance, and free-flowing traffic were some of the most important features of the trails (Lindsey, Greg, et al). An overall theme of this report's findings was that the trails bring great value to the area and serve as a point of opportunity, whether it be for better health, access to more cultural neighborhoods, or for economic opportunities (Lindsey, Greg, et al).

Cleveland, Ohio, a mere 143 miles northeast of Columbus, contains a large network of interconnected Metroparks, similar to those around the central Ohio region. The economic

benefits of the Cleveland Metroparks was analyzed in a 2018 report done by the Trust for Public Land (The Trust for Public Land). A main theme of the report was that the reservations and trails within the Cleveland Metro Park network were highly beneficial to the local communities in terms of economic well-being (The Trust for Public Land). It recognized the multitude of positive impacts on the community, such as enhancing property values and providing recreational opportunities. The report goes on to list numerous additional benefits of the Metroparks on the Northeast Ohio community, noting that the system "reduces stormwater runoff, filters pollutants from the air, attracts visitors to the community, provides recreational opportunities for residents, contributes to the multimodal transportation network, improves community health, and boots economic development" (The Trust for Public Land).

A multimodal transportation network includes cycling, and a 2016 report by The League of American Bicyclists detailed bicycle commuting in American cities. Overall, Ohio had increased between 40-69% in the number of people commuting by bike from 2006 - 2016 (League of American Bicyclists). When considering Cleveland and Columbus, on a list of the top 70 largest cities with highest share of bicycle commuters, Cleveland ranked 23rd with 1.1% of bike commuters and Columbus ranked 43rd with 0.6% of bike commuters for each municipality's population (League of American Bicyclists). From 2000-2016, Cleveland's bicycle commuting growth was nearly 400%, and Columbus' increased by 69.1% (League of American Bicyclists). This growth indicates a greater desire for commuting by bicycle, and therefore, it indicates the benefit of full bicycle infrastructure.

Both Cleveland and Columbus experience a winter season, which may influence cyclist ridership. In a study examining bike sharing during the winter in the United States, multiple opportunities for expanding bike share during the winter were identified. Bicycle riders in one of

the coldest cities in the United States – Fargo, North Dakota – were surveyed on their willingness to utilize a bikeshare program during the winter (Ranjit). Of those identified as regular bike share users, 96.3% indicated willingness to use bikeshare in winter. The willingness to use such a program in the winter increased to 96.9% with a further condition that paths and sidewalks get cleared of snow and ice. The same was true of the "Occasional Bike Share Users" and "Infrequent Bike Share Users" which indicated a demand (Ranjit). Snow removal was a major factor as 83.4% of those surveyed indicated that road condition may hinder their desire to bicycle in the winter. The article further estimated that approximately 10-30% of summer ridership could be expected during the winter should bikeshare operations be made available.

In order to understand bicycling habits in cold weather climates, professors Mohammad Amiri and Fanaz Sadeghpour from the University of Calgary surveyed bicyclists in Calgary, Canada to uncover the role of weather in the decision-making process of cyclists in inclement weather. The study involved surveying bicyclists utilizing a bicycle lane in Calgary. Of the frequent cyclists, 72% biked 10 or more times per week, but in comparison, during cold weather, only 42% of frequent cyclists maintained that frequency (Amiri and Sadeghpour). This was attributed to safety concerns cyclists had which included worry over icy conditions (61%) and gravel/snow in lane (53%) (Amiri and Sadeghpour). Other concerns involved obstacles such as parked cars and drivers' attitudes. Furthermore, of those surveyed, 38% stated that weather did not make any impact on their decision to bike, and another 33% stated willingness to cycle in temperatures as low as -4 degrees Fahrenheit (Amiri & Sadeghpour). Another study done by a joint team of researchers with the University of Vermont College of Medicine and Transportation Research Center examined how weather impacted decisions related to commuting to work by bicycle (Flynn et al). Their study indicated that a 1 degree Fahrenheit increase in

temperature increased possibility of biking by 3% whereas 1 inch of snow on the ground would result in a 10% decrease in possibility (Flynn et al).

Other barriers exist beyond weather and temperature. In a study done by PeopleforBikes, an advocacy organization for bicycling, over 16,000 adults ages 18 and older took a survey focused on bicycling (Breakaway Research Group). That year, 15% or 45.1 million Americans utilized bicycles. Seen as a convenient way to travel, 54% said it was expedient and 53% would like to ride a bicycle more often. However, a prominent barrier to increased use was fear of motor vehicles. Mitigating this fear could be accomplished by better infrastructure; a major component of this task is the creation of separate lanes for bicycles. Around 46% of adults claim that if bike-only lanes were available, they would be more likely to opt for this mode of transportation  Of those surveyed, a vast majority (57%) said they rode a bicycle for only recreation, while only 8% indicated that they used a bicycle solely for transportation. The overlap, however, was the 36% who indicated they use a bicycle for both recreation and transportation, both of which are characteristic of the Central Ohio Greenways.

## Chapter 3: Research Design

The aim of this research was to better understand how the Central Ohio Greenways surrounding Columbus were utilized during winter. In this case, winter refers to the season that began with the winter solstice on December 21, 2020 and ends with the spring equinox on March 20, 2021. Data collection mirrored the methodology adopted by the MORPC during their data collection efforts from April 19$^{th}$, 2020 to September 26$^{th}$, 2020 for the 2020 Volunteer Bicycle and Pedestrian Counts. MORPC had identified 17 segments of trail which volunteers attended during a two-hour period on any day of the week to manually tally the various modes of

transportation they observed. The mode choice categories were Bicyclists, Pedestrians, Mobility Aid devices, Electric Scooters, and Other. “Mobility aid” included people using a wheelchair, baby stroller, or similar device, as well as small children being carried. “Other” included people using skates, skateboards, and other non-motorized methods of travel.

Of these 17 locations, two specific locations were chosen for this research based upon the data from 2020. Olentangy Trail at Antrim Park and Scioto Trail at North Bank Park were chosen as they were two of the top three most utilized trails on average per hour (“2020_Volunteer”). It was assumed that the trails most utilized in the spring and fall would still have higher usage in the winter and would allow for more data and allow for more data collection. The highest hourly average trail segment, Olentangy Trail at OSU [The Ohio State University] Wetlands, was discounted due to the proximity to The Ohio State University main campus. With students back on campus at the time of data collection, the decision to disregard that location was intended to avoid a possible significant skew in the data and comparison

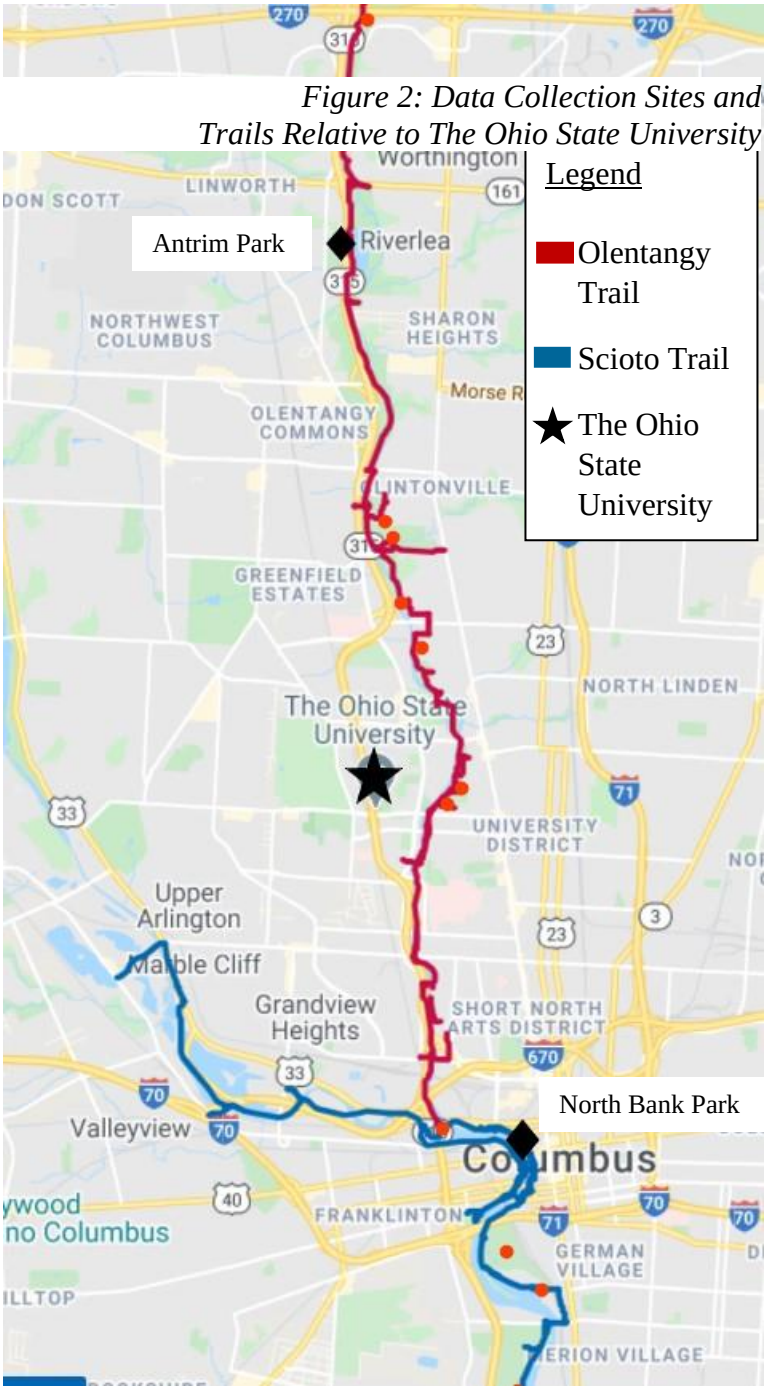


*Figure 2: Data Collection Sites and Trails Relative to The Ohio State University*

abilities to the MORPC report. Antrim Park is approximately 6 miles north of campus, and North Bank Park is approximately 2.5 miles south of campus. Both Olentangy Trail at Antrim Park and Scioto Trail at North Bank Park were determined to be distant enough from OSU main campus that they would be minimally impacted by the student population present at time of study.

The methodology for the MORPC study allowed for a volunteer to go for any two-hour increment between the hours of 7 AM and 7 PM on any day of the week for which they had signed up. Further, the count period had to start at the top of the hour; for example, one would have to count from 1 – 3 PM. Starting at 3:30 until 5:30 PM was not permissible. For the purpose of this research, that same idea was put into practice, and each session began at the top of the hour. However, two specific time slots were chosen for each day. The first observation period was from 8 – 10 AM, and the second observation period was from 4 – 6 PM. These times were specifically chosen due to research indicating that people most often exercise during those hours (Porter). An assumption made during this process was that most users would be utilizing the trail for recreation instead of for commuting or other purposes. These times were also designated as such because they are the times before and after typical workdays. Therefore, the trails would most likely to be utilized before and after those times. The hour of 7 – 8 AM and 6 – 7 PM was not included due to the rising and setting of the sun during those hours. Most data collection was done independently without a partner or acquaintance present. The decision to not collect data during those two hours was meant to avoid being alone before or after dark for safety purposes. Each park/trail segment was visited daily to record the users present within each time block.

Going daily to each site was intended to help mitigate issues of constantly changing weather and to allow data collection during the weather of the day for each location. The location rotated between both observation points each day. For example, if data was gathered today at

Antrim Park in the morning and North Bank Park in the evening, then tomorrow, North Bank Park would be observed in the morning and Antrim Park in the evening. An example of the data collection sheet can be viewed in Appendix A. Individuals were also observed to what they appeared to be doing such as running or walking a dog. Data was collected and organized in 15-minute increments and included individuals going in both directions past the checkpoint. One sheet of paper was utilized per one hour of data collection.

## Chapter 4: Findings and Analysis

### *Data Review*

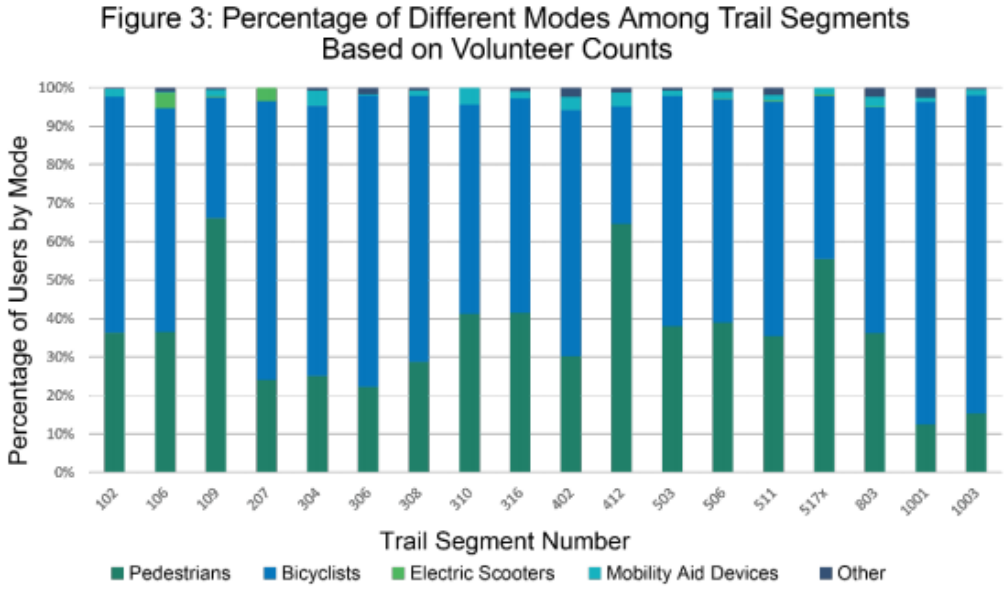
Data collection for this report was based upon the 2020 Volunteer Bicycle and Pedestrian Counts during the spring and fall of 2020 done by Mid-Ohio Regional Planning Commission (MORPC). However, this study's data was focused during the winter of 2021. The dates for the winter collection span from February 23, 2021 to March 19, 2021. According to the astronomical calendar, these dates occurred after the winter solstice and before the vernal equinox. There was no overlap of dates between this data collection and that that of MORPC; MORPC began their spring count on April 19th, 2020 and ended it May 16th, 2020. The fall count occurred from August 30th, 2020 to September 26th, 2020. The entire data collection occurred during the COVID-19 pandemic, which was declared a pandemic on March 1, 2020 (AJMC Staff). However, in the United States, a public health emergency was declared on February 3, 2020. This is significant, seeing that the COVID-19 pandemic is estimated to have caused an approximate 70% increase in trail usage across Columbus, Ohio (Cardoni).

During the time of the winter data collection at Olentangy Trail at Antrim Park and Scioto Trail at North Bank Park, over 11,000 people were counted within the categories of

Bicyclist, Pedestrian, Mobility Aid Devices, Electric Scooters, and Other. In a summary of the data collected by volunteers for MORPC, all mode choices were added to create a pie chart depicting the ratios of each category. In the MORPC study, with the largest sum of total trail users, Bicyclists accounted for 58% of the total users ("2020_Volunteer"). This was approximately 8,339 people. Further, Pedestrians constituted the second largest category with 38.7% (5,553) of the total trail users. Mobility Aid Devices, Other, and Electric Scooters accounted for 1.7% (246), 1.2% (175), and 0.4% (54), respectively.

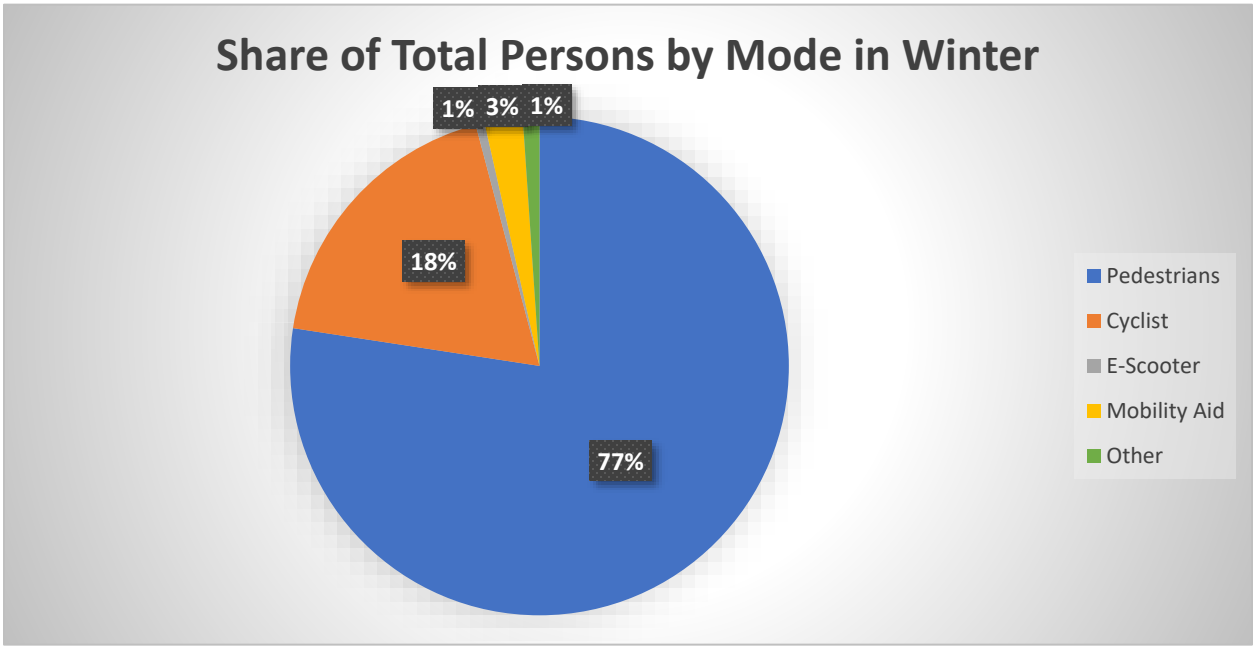
This distribution within the MORPC study was similar to the two specific sites considered for the winter study. As shown in Figure 3 from the MORPC study, location 106, which was Scioto Trail at North Bank Park, was mostly utilized by bicyclists and second most by pedestrians ("2020_Volunteer"). Similarly, location 506, Olentangy Trail at Antrim Park, was mostly utilized by bicycles with pedestrians as the second highest mode choice.

*Figure 3: MORPC Chart of Percentage of Different Modes Among Trail Segments Based on Volunteer Count*



The result of Bicycle as the majority mode choice and Pedestrian as the second largest mode choice within the MORPC data changed during the winter data collection. Pedestrians made up the vast majority of trail users during the winter, accounting for 77% of the total users observed. Bicyclists were the second largest category accounting for 18% of total users. The total distribution is depicted in Figure 4 below.

*Figure 4: Share of Total Persons by Mode Choice during Winter Collection*




Every single day of data collection, during both time blocks of the day and at each location, Pedestrians constituted the majority of trail users. The total number of users each day at both time blocks tended to be highest at Antrim Park (blue) which is shown in Figure 5 and Figure 6 below. On average, for both parks at both times on all days, there were 263 trail users. In the evening (4 – 6 PM), this average was close to double at 411, whereas, in the morning (8 – 10 AM), the average was only 100 users. The evenings, with an approximate quadruple that of the morning average, was the more popular time of day.

*Figure 5: Total Number of Trail Users by Day in Morning (8 - 10 AM)*

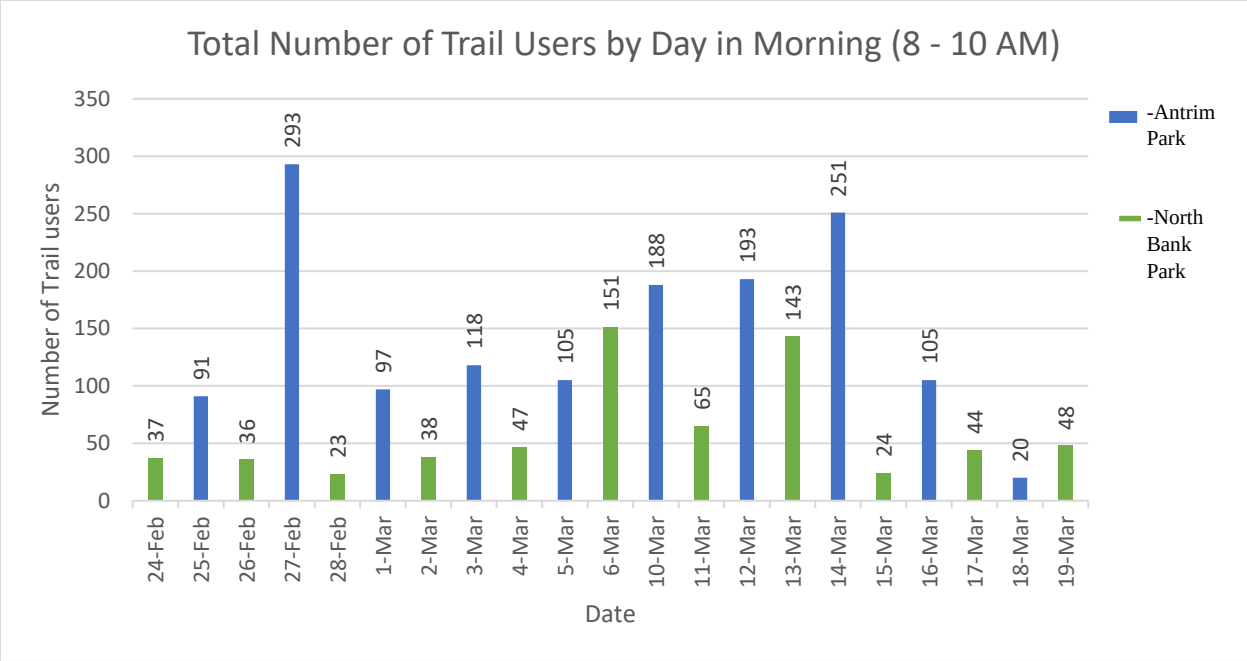
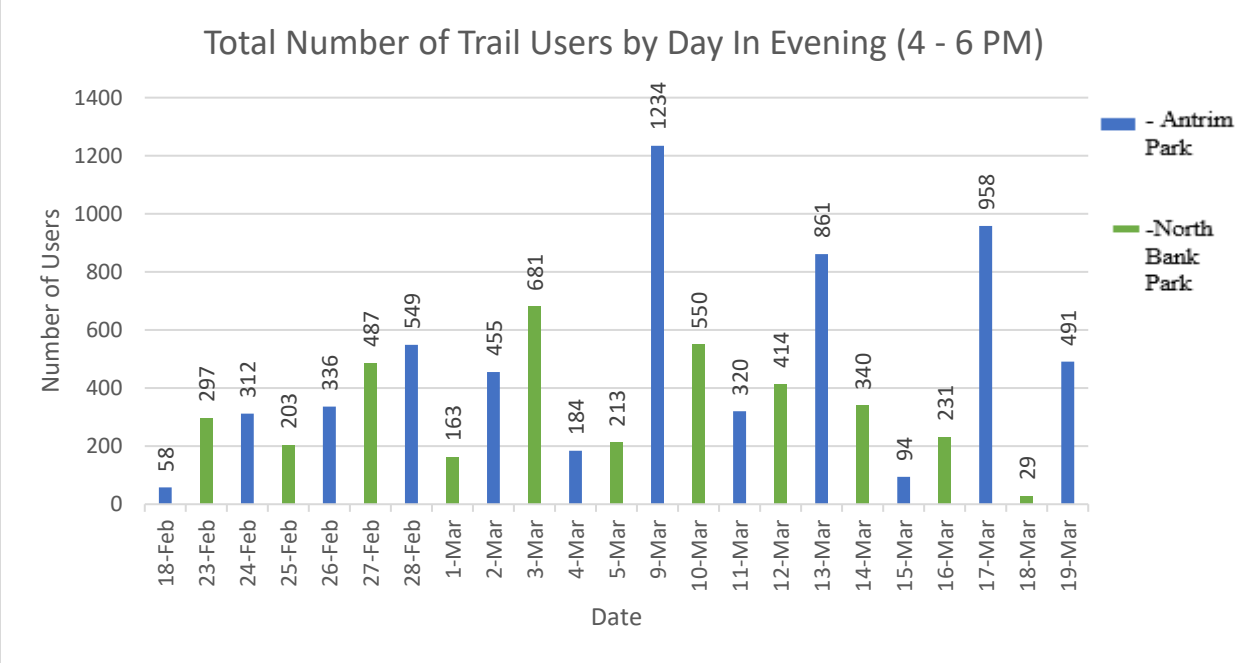



*Figure 6: Total Number of Trail Users by Day in Evening (4 - 6 PM)*



The main focus of this research, bicyclists, were most significant during the evening as indicated in Figure 7 below. The green columns indicate a count taken at Antrim Park in the evening, and the yellow columns indicate a count taken at North Bank Park in the evening. On average, in the evening at Antrim Park, 91 bicyclists utilized the trail.

Antrim Park from 4 – 6 PM was the time and location with 3 out of 5 of the highest bicyclist count time blocks. However, despite the high number of bicycle users at Antrim Park, there were days in the 4 – 6 PM time block that had low numbers. The two days with the lowest sums for Antrim Park (from 4 – 6 PM, March 15 (7) and March 4 (17) ) had inclement weather (See Figure 7 below). Both of these dates experienced weather that included snow during the evening time block. On days with any type of precipitation, whether it be a hard rain, drizzle, or snow showers, the number of bicyclists was below average. Ten total 2-hour increments experienced precipitation, but four of those had only slight drizzles (See Figure 8). As a result, users were still above the total average. For days with harder rain or snow, trail users were at a minimum 79 users below average and at maximum 243 users below average. Even on days that were sunny, if the temperature was below 32 degrees Fahrenheit, or freezing, no more than 9 bicycle users were on the trail over a 2-hour period, regardless of time of day or location (See Figure 9).

*Figure 7: Number of Bicycle Users by Date, Time, and Location*

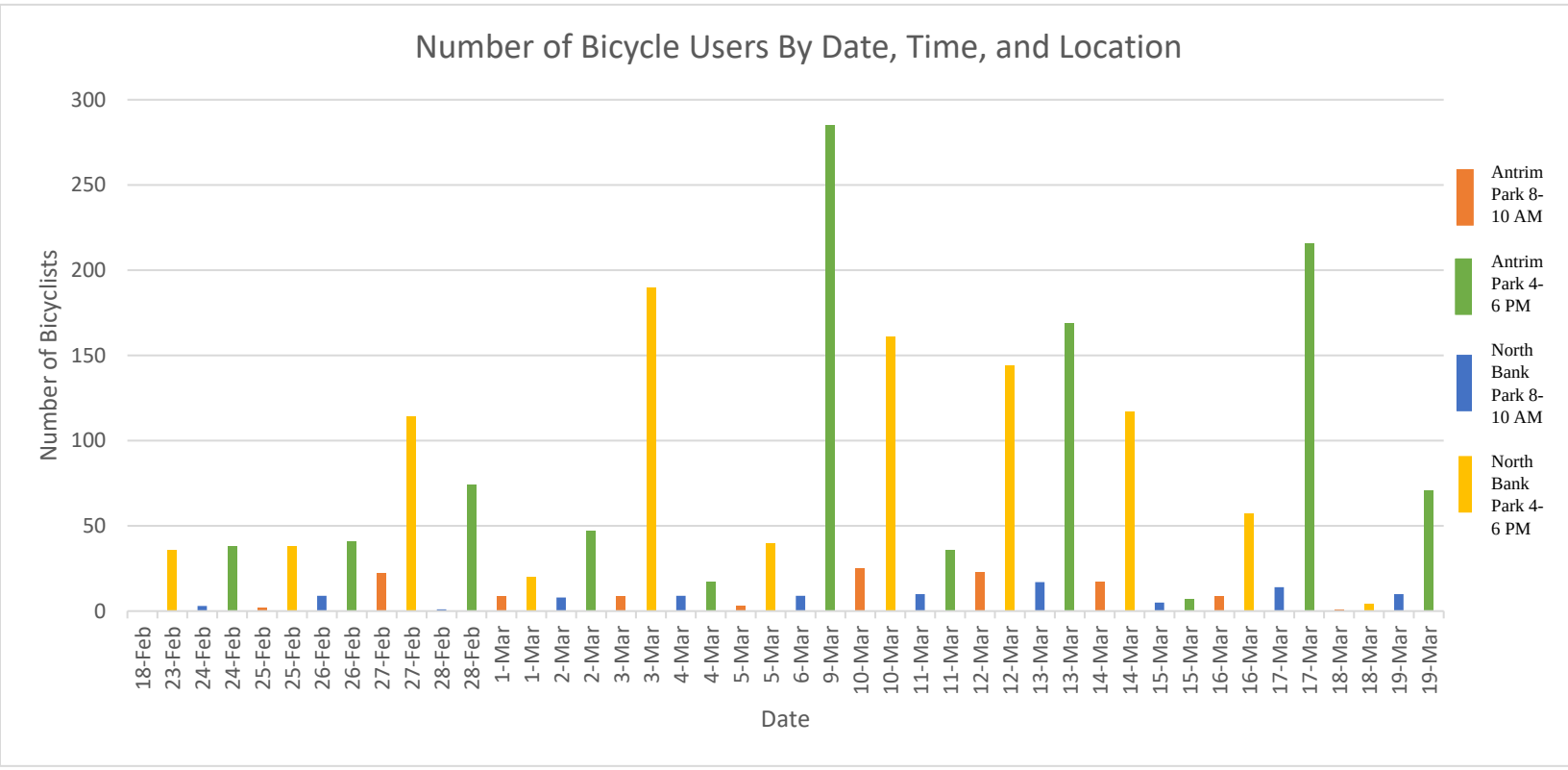



*Figure 8: Total Trail Users on Days with Precipitation*

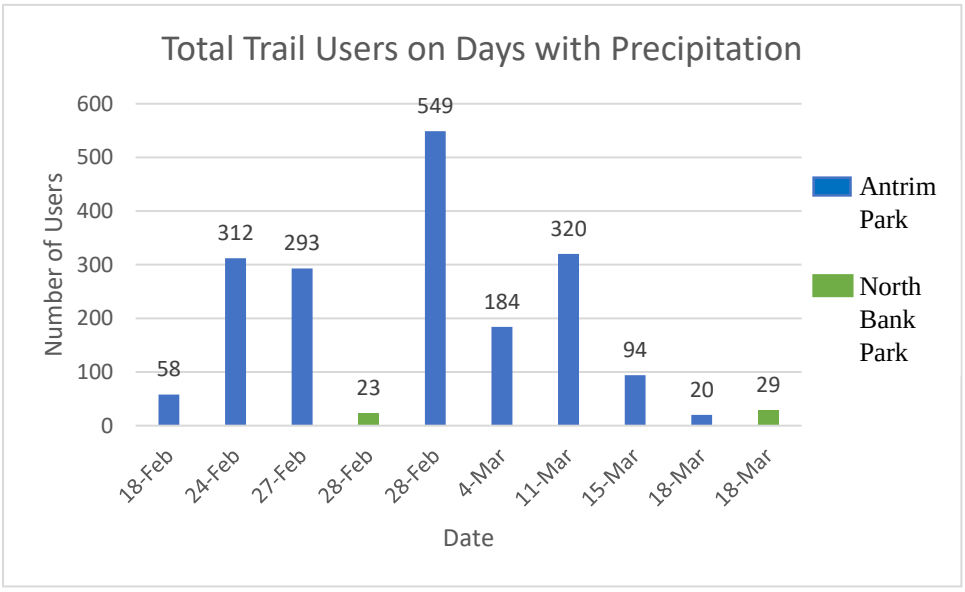
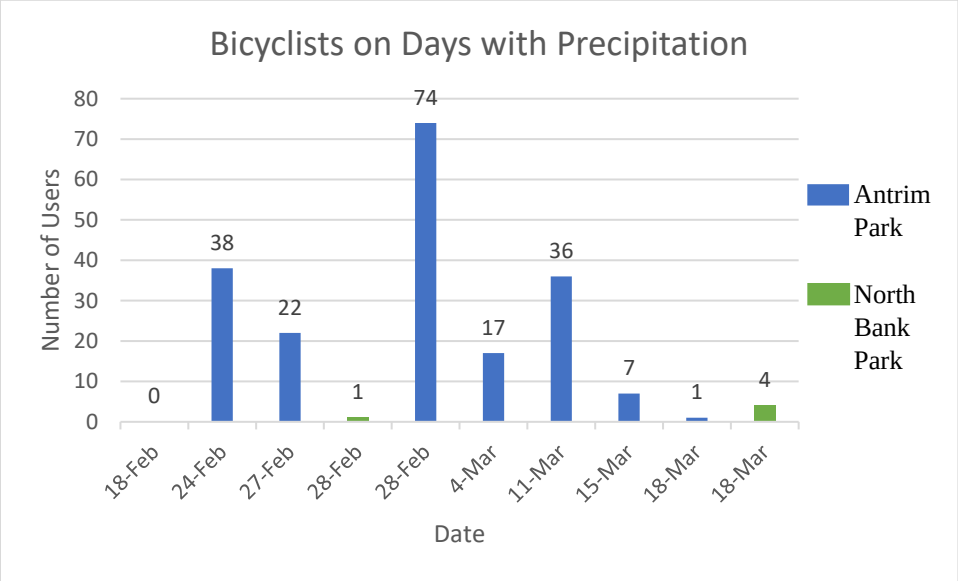


*Figure 9: Bicyclists on Days with Precipitation*




In contrast, when a day was much warmer without precipitation, such as March 9th at Antrim Park in the evening, large numbers of people were recorded. Not only was March 9th the largest sum of bicyclists with 285, but it was also the largest number of users overall with 1,234 trail users. I assume this result was due to two main factors; March 9th was one of the first 60+ degree days of the year, and it was approximately the one-year anniversary of COVID-19 being declared a pandemic. Therefore, I assume that given these factors, individuals may have been more apt to utilize the trail than they otherwise would have been due to improving weather and lockdown guidelines that led to increased time spent in one's own home.

Data compiled at the University of Oxford within the Martin School showcases how the number of visitors changed within parks and outdoor spaces during the COVID-19 pandemic ("Parks and Outdoor Spaces"). There have been peaks and valleys of increased and decreased visitation. Thus far, peak visitation was reached in July 2020 when there was a 60% increase of

visitors to parks. However, during the colder months of November 2020 – March 2021, visitation was consistently below average, hovering around the -20% mark ("Parks and Outdoor Spaces").

Overall, temperature and trail usage are highly correlated. As depicted in Figure 10 and Figure 11, as temperature increases, so too does the number of total users and bicyclists, respectively.

*Figure 10: Total Trail Users Per Time Block Per Temperature*

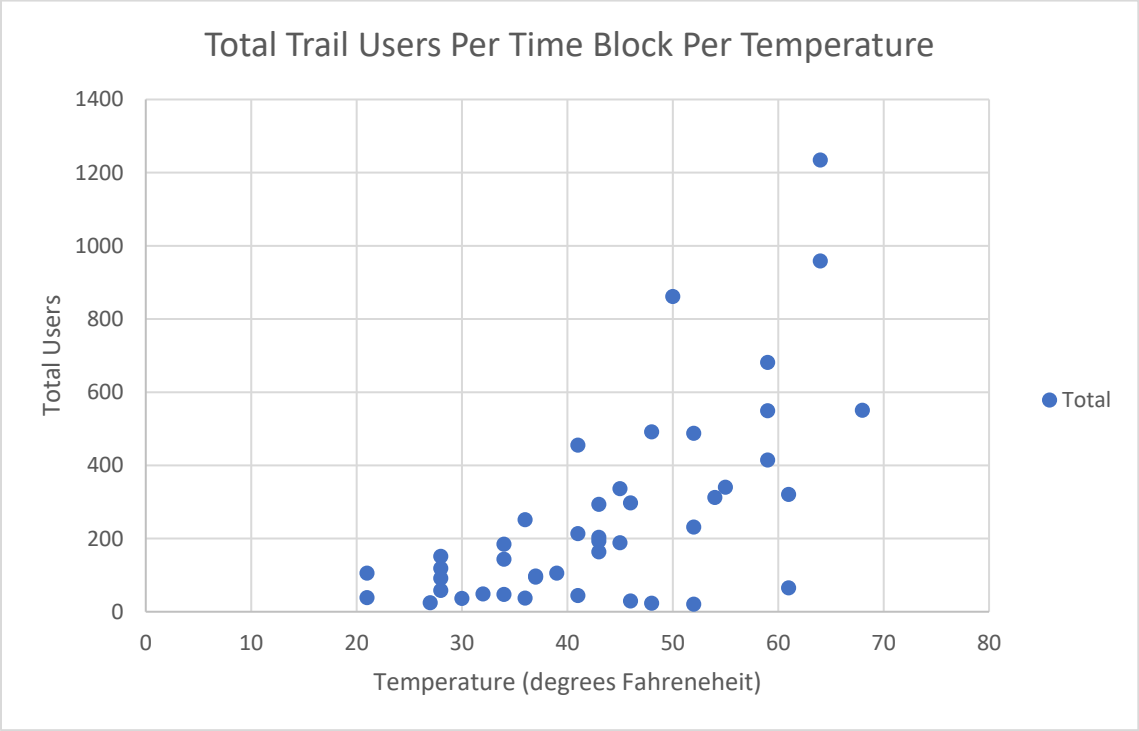
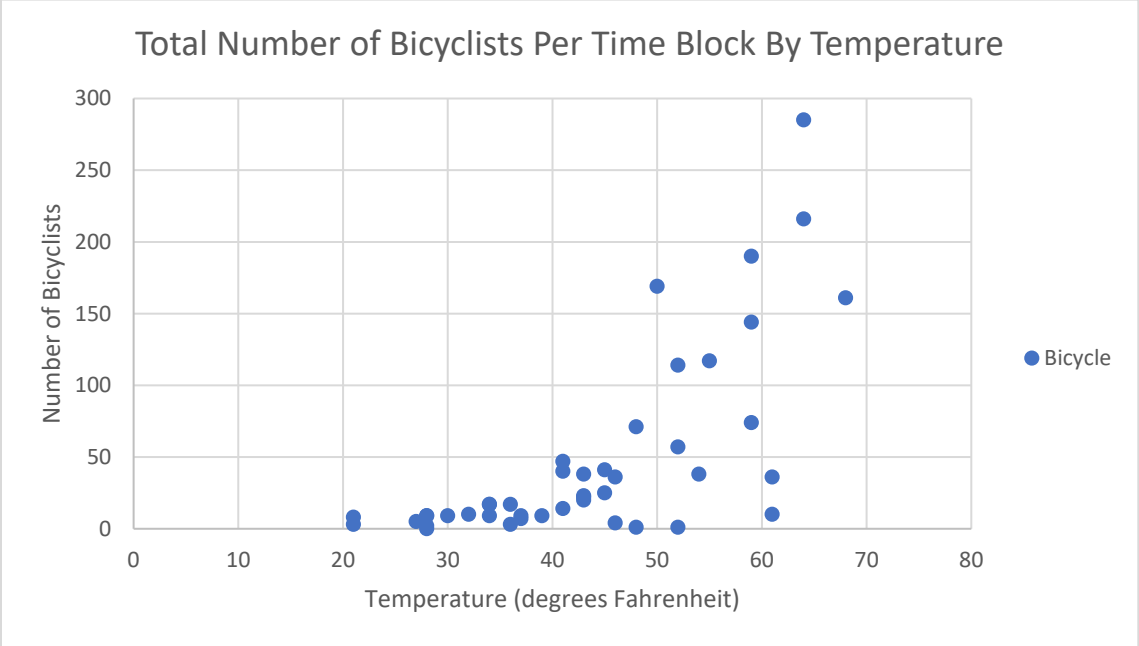


*Figure 11: Total Number of Bicyclists Per Time Block By Temperature*




The main purpose of this study involved analyzing how the Central Ohio Greenways were utilized during the winter months at two locations that were highly observed during the original study by MORPC during the spring and fall. While the MORPC study indicated bicycles as the majority mode choice, the winter collection done for this study indicated bicyclists were the second largest category behind pedestrians. While bicycles in the spring and fall constituted almost 58% of the total users, comparatively, only 18% of users in the winter utilized bicycles. This 40% change indicates a major change in mode choice as 77% of individuals during the winter were pedestrians. The Central Ohio Greenways are underutilized as a way of transportation for those on bicycles during the winter; however, two North American cities showcase the standard that Columbus can strive to achieve.

*Case Study Analysis*

Portland

Cycling has been on the rise in Portland since 1985. This is credited to improvements in technology, such a wider tires, heightened environmental awareness, and better cycling conditions (City of Portland 9-10). The importance of bicycles within the city is evident due to the creation of the Bicycle Master Plan over forty years ago that had a goal of "Making bicycling an integral part of daily life in Portland" (City of Portland 10). Some historical markers include:

- 1972: Bicycle Path Task Force created
    - Produced 1973 Bicycle Master Plan
- 1978: Citizen's Bicycle and Pedestrian Advisory Committee created
- 1979: Bicycle Program started by Portland Office of Transportation
- 1994: Bicycle Program started Bicycle Facility Improvement Program

The Bicycle Master Plan further identified eight objectives with an established benchmark system to check progress. These objectives were as follows (16):

- Complete a network of bikeways that serves bicyclists' needs, especially for travel to employment centers, commercial districts, transit stations, institutions, and recreational destinations;
- Provide bikeway facilities that are appropriate to the street classifications, traffic volume, and speed on all rights-of-ways;
- Maintain and improve the quality, operation, and integrity of bikeway network facilities;
- Provide short- and long-term bicycle parking in commercial districts;
- Provide showers and changing facilities for commuting cyclists;
- Increase the number of bicycle-transit trips;

- Develop and implement education and encouragement plans;
- Promote bicycling as transportation to and from school

These listed objectives within the document indicated the desire to continue working to significantly improve the bicycle network early on. The number of bicyclists in Portland has been increasing. In 2017, 6.3% of Portland commuters did so by bike ("Bicycles in Portland"). Comparatively, on a national scale, only 0.6% of commuters utilize a bicycle (League of American Bicyclists). Portland has 385 miles of bikeways, 94 of which are neighborhood greenways ("Bicycles in Portland").

Portland has greenways of their own that are slightly different than those in Columbus. The neighborhood greenways within Portland were formerly known as "bicycle boulevards" ("What are Neighborhood Greenways?"). These greenways are within residential streets that are made to enhance bicycling. They include connections between neighborhoods, parks, schools, and business districts.

Situated in the Pacific Northwest of the United States, Portland has a different natural climate than Ohio. The temperature usually falls in a range of 36° Fahrenheit to 84° Fahrenheit ("Average Weather"). Further, during the wet season, from October to May, each day has a 32% chance of being considered a wet day. A study that compared data from four different cities with inclement weather, including Portland, concluded that temperature was generally significant, and that precipitation has a negative effect on the numbers of bicyclists (Nosal & Miranda-Moreno). Furthermore, the duration and timing of precipitation can make a major difference on the volume of bicyclists on any given day. However, despite Portland's inclement weather, its bicycle culture is formidable and results in consistently high usage of bicycles.

Montréal

Montréal, Canada ranks as the 18th city out of 20, an impressive achievement, on the latest Copenhagenize Index from 2019. The Copenhagenize Index is "the most comprehensive and holistic ranking of bicycle-friendly cities on planet earth" (Wexler et al.). Montréal is the only North American city to be in the Index every year since its beginnings in 2011 (Wexler). This index was established after extensive research on over 600 cities with populations greater than 600,000 (Bubbers). Cities with a bicycle modal share above 2% are taken from the pool of 600 cities and put into a second round wherein each city is evaluated based on 14 different categories ("Our Methodology"). Of the three main categories that the 14 evaluators are split into, Montréal scored highest (3 out of 4) in the "Ambition" category (Wexler et al.). This score is due to an elected leader who introduced a bicycle-focused project. However, the Index recognizes that the bicycle network in Montréal needs improvement. Still, when compared to other cities in North America, it has advanced since the early beginnings of its network began in the 1980s, whereas multiple large North American cities, such as Miami, Florida, still lack a bicycle network (Robertson).

In the 1980s, Montréal installed segregated on-street cycling infrastructure. The beginnings of bicycle interest in the city originate with Robert Silverman in 1975, who led a movement of artists protesting the lack of bicycle infrastructure (Walker). In addition, Velo Quebec started in the 1960s and provided tours by bicycle. Velo Quebec created the Tour de L'Ile, that in 1986 had approximately 15,000 participants. Denis Coderre, a former parliamentarian praised the initiative, stating, "Velo Quebec and all the other, they have helped change the culture" (Walker). Notably, it was a movement that originated in the community that created the culture currently seen today in Montréal.

While Montréal has been on the Copenhagenize Index since 2011, it has steadily dropped in rank. However, with new plans announced, Montréal has the potential to create sweeping changes for the city. One of these announcements occurred in 2017 when a $150-million plan was publicized to improve the bicycle network (Singh). It outlined ten steps that were to be taken, including:

> "1. Deployment of the Montréal cycling network, which is based on greater connectivity, better access to clusters and more complementarity with public transit
>
> 2. Conversion of the Montréal bicycle network into an accessible and safe network in all seasons
>
> 3. Development of a downtown bike accessibility plan
>
> 4. Realization at the metropolitan scale of bold, structure, and large-scale bicycle projects
>
> 5. Improvement of the supply and quality of parking for bicycles throughout the territory of Montréal and particularly in the central districts
>
> 6. Integration of cyclists' needs into the existing road network and in street improvement and redevelopment projects
>
> 7. Implementation of facilities or equipment based on innovation and new technologies and in line with the functionalities of the intelligent and digital city
>
> 8. Implementation of projects and programs directed at organizations or cultural communities to support and promote initiatives to encourage cycling
>
> 9. Development of partnerships with sporting and community organizations, schools, leisure groups, etc., to meet the needs of all clientele
>
> 10. Promotion of cycling as a safe, efficient, and comfortable mode of transportation" (Singh).

Montréal currently has over 435 miles of bike paths throughout the city (Fadden). In addition, the Express Bike Network is a project by the city of Montréal aimed at increasing the bike paths by an additional 184 kilometers with paths that will be accessible year-round ("EBN"). The paths would be isolated, and the idea is to create a separate space for cyclists so that each mode of transportation has their own space.

These year-round paths would make a big impact. Between 1996 and 2016, Montréal saw the largest increase among Canadian cities in rates of cycling to work with a nearly threefold increase of 1.3% to 3.6% (Verlinden et al.). Additionally, in 2016, Montréal neighborhood La Petite-Patrie ranked as one of the highest cycling to work neighborhoods in Canada with 22.6% of the population using a bike to get to work. This increased use was also evident this past year, when, due to the pandemic, increases in bicycle ridership occurred in Montréal (Magder). And, for the first time this past winter, the bike paths were being cleared of snow and ice regularly throughout the winter season. This aligns with Montréal's Four Season Bike Network that started in 2014 and detailed the maintenance of 260 kilometers of bike paths (Verlinden et al.). By 2019, this initiative included over 500 kilometers of bike paths which constituted 76% of the infrastructure for bikes in Montréal. Velo Quebec did a study of the City of Montréal to evaluate what would dissuade or persuade individuals to cycle in the winter. According to Magali Bebronne, the project manager for this study, the single largest determinant was conditions of the road (Magder).

Maintenance for the bike paths in the city would create fewer issues for cyclists in Montréal. The city has an average January temperature of 14° Fahrenheit with the average number of days of snow above 2 milometers (< 1 inch) at 54 days (Verlinden et al.). In a plan released by The Centre for Active Transportation that details ways to increase cycling in

Canadian cities, the plan states, “Municipalities can address the challenges of hilliness and weather through a combination of infrastructure and programming to make cycling a more attractive option throughout the year for people of all fitness levels” (Verlinden et al.).

Montréal’s cycling has increased, and it is a result of more than just infrastructure. In a study done to examine what factors increased cycling in Canadian cities, bicycle supply was mentioned as a factor without much impact in most cities except for Montréal (Assunçao-Denis & Tomalty). In Montréal, BIXI, the first large-scale bike-sharing nonprofit in North America,has been cited as a key factor in increasing Montréal ridership. BIXI has over 8,000 bikes and 660 stations across the city and surrounding areas (“We are BIXI Montréal”).

Overall, Montréal has over one million cyclists, most of which utilize their bikes at least once a week (Marchand). When using a bicycle, most trips (40%) are for the purpose of getting to a specific place. This is a large proportion of total rides which indicates a need that the city is prioritizing. Marc-Andre Gadoury, the bicycle-focused city councillor, indicated a city plan to increase the bike path network to 1,280 km in the future (Marchand). This expansion would not only add to the culture of bicycling in Montreal, it would also create an extensive network for the city’s one million cyclists.

## Chapter 5: Discussion

Columbus is a diverse city, and with an estimated increase of a million people in the next 30 years, consideration must be made about how development will occur. One such consideration is transportation and commuting to work. A multi-modal transportation includes not only cars, pedestrians, and public transportation, but it also includes bicycle infrastructure. Columbus has a large network of bicycle trails called the Central Ohio Greenways. The Greenways do not only support recreation, they also support a multi-modal transportation

network. A study done by MORPC during the spring and fall of 2020 indicated a majority of mode choice was bicycle. However, in original data collected for this thesis during the winter, pedestrians were found to be the majority mode choice with close to 80% of the distribution. Bicycles only constituted of 18% of total users. Inclement weather appeared to have a significant impact on the percentage of bicyclists as there was a clear correlation between temperature and volume of bicyclists. Similarly, on days with harder rainfalls or snow showers, fewer bicyclists utilized the trails compared to clear and slight rain days.

Despite inclement weather and winter climates, two Western European countries, Denmark and the Netherlands, have cities that consistently rank highly as the most bicycle-friendly cities in the world. This friendliness towards bikes results in high usage of bicycles for commutes, no matter the weather. Yet Columbus, a city that experiences similar weather to that of Copenhagen and Amsterdam, has an underutilization of bicycles during the winter months. As these cities are European and their development is different, some skepticism may exist over the comparability to North American cities, however, two great North American examples include Portland, Oregon and Montréal, Canada. These cities boast extensive bicycle networks and a pervasive cycling culture that lend themselves to higher percentages of usage than those seen in Columbus, Ohio. Columbus is loosely indicative of more national demographics and trends which is why it has, for many years, served as a testing ground for products (Moberger). In fact, the percentage of workers that commute by bicycle in Columbus is approximately equal to the national percentage of workers that commute by bike.

Infrastructure is a foundation for a booming bicycle culture. In Copenhagen, significant mileage of bikeways exists for users to traverse the city. In Montréal, a bike network with efforts to continue its growth to over 1,000 km of trail holds great promise for a city which has focused

on bicycle travel since the 1980s. In Columbus, the Central Ohio Greenways consist of 230 miles of trails and a vision to create more ("About Us"). MORPC, the metropolitan planning organization for central Ohio, created a Regional Trail Vision Prioritization for the Central Ohio Greenways (MORPC). The Regional Trail Vision was adopted by local governments in 2018 and the plan proposed 500 miles of new trails to create an interconnected network.

For the existing network, MORPC studied Franklin County residents' accessibility to the Central Ohio Greenways (MORPC). For a ½-mile walkshed around each trail access point, 14% of the county's population has access by walking to the nearest trail point. A walkshed is "the area around a station – or any central destination – that is reachable on foot for the average person" (Swanson et al.). In terms of biking, for a 1-mile bike shed, 27% of the population in Franklin County has access to the trails (MORPC). Columbus is a large and sprawling region, so the gaps between trails add a level of difficulty to accessibility. With the proposed expansion and connection points for the trails, 40% of the population will be within the ½-mile walkshed and 1-mile bike shed for the trails which greatly improves the percentage of accessibility for residents. Fulfilling this vision will cost approximately $250 million, as each new mile of trail costs approximately $500,000 (Murdock et al.). While this price tag may seem high, it is necessary for bicyclists to have appropriate, safe infrastructure in the winter. In studies surveying cyclists that bike throughout the winter, there was a 30% decrease in the riders that biked during the cold weather due to safety concerns (Amiri and Sadeghpour). This safety extends beyond infrastructure to maintenance.

Maintenance of bike lanes is an important aspect of maintaining use of the trails. Copenhagen prioritizes their bike lanes above regular traffic lanes during inclement weather (Citation). The Metro Parks took over maintenance of the greenways in 2010 (Rinehart). During

the winter data collection, multiple Metro Park vehicles were observed as well as smaller utility vehicles working to collect trash and maintain the trails. In the Metro Parks 2021 budget, park maintenance alone accounts for over 2 million dollars of expenditure (Moloney). In 2015, the total annual maintenance costs for the trails specifically was approximately $519,000 to clean off the trails from debris and snow (Ramsey). Ultimately, the price has been found to be worth it, and the resources exist to ensure safety and readiness of the Central Ohio Greenways for bicyclists.

Infrastructure and maintenance serve as a basis for the overall bicycle culture. Advocacy and education were other large components of creating a bicycle culture. In Montréal, initial protesting and advocacy were the beginnings of the city's focus on bicycles. Large bicycle rides like the Tour de L'Ile were just one of the ways advocacy was done (Walker). Similarly, advocacy groups exist within Columbus such as Yay Bikes! that aim to help improve conditions for cyclists commuting to work ("Bicycle Advocacy"). As a member of the Central Ohio Greenways Board, Yay Bikes! works to expand and advocate for the network. They also have group bike rides like the Ride of Silence meant to raise awareness about bicyclists' right of way. This organization and others serve as points of education and advocacy within Columbus that are useful tools in pushing towards a culture of bicycle transportation.

The Central Ohio Greenways are a significant part of the natural landscape and an immense opportunity for Columbus to expand upon. Other cities and countries exist as examples and blueprints for ways to improve the bicycle-friendliness of Columbus, especially during the winter. Whether it be through expanded infrastructure, enhanced maintenance, or greater education surrounding bicycling, Columbus has the potential to create a stronger bicycle culture. Unsurprisingly, usage of the Central Ohio Greenways decreased during the winter months with

the cold and inclement weather. However, the weather is inexcusable with examples of other cities such as Copenhagen that maintain high ridership despite inclement weather. Columbus is projected to continue growing in the long-term, and investing in a more interconnected, well-maintained, and widely accessible bike network has the potential to create cultural change in the city for bicycles that would significantly change mode choice for those living in the region.

*Limitations, Reliability, and Future Study*

There are a few limitations for this study. First, human error could have led to a number of issues related to incorrect count of users, incorrect data recording, and other mistakes. Another limitation of the study exists in that compared to the MORPC data collection, not every trail was able to be visited, and observed trends may be different related to usage at the other trails. Third, there was limited time to conduct data collection. The sporadic nature of weather also contributes to a limitation with this study. The majority of the data was collected during the month of March, and March of 2021 was warmer than average (Perkins). Therefore, days that features below freezing temperature and heavy snowfall were limited.

This study led to more questions that could be investigated with further study. In the future, more research could be done during and directly following heavy snowfalls. As the astrological calendar dictates that winter lasts from December until March, more data collection could be done earlier in the year. Additionally, while the MORPC study involved data collection during the spring and fall, the summer did not have a data collection period. Therefore, the greenways could be observed during the summer to give a more holistic understanding of the usage of greenways throughout the year. Specifically related to bicyclists, Columbus has a small

network of bicycle lanes throughout the city. Further study could involve studying both the greenways and bike paths during a set time to understand cyclist behaviors.

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## Appendix

*Appendix A: Data Collection Sheet*

**Data Collection Example Sheet:**

Date:
Time:
Hour of this sheet:
Location:
Weather:
Trail Condition:

| | 00-15 | 15-30 | 30-45 | 45-60 |
|---|---|---|---|---|
| Pedestrian | | | | |
| Bicyclist | | | | |
| E-scooter | | | | |
| Mobility Aid | | | | |
| Other | | | | |

Notes and other observations:

*Appendix B: Daily Time Block Totals Data Spreadsheet*

| Date | Time | Location | Pedestrian | Bicycle | E-Scooter | Mobility Aid | Other | Total | Temp | Weather |
|---|---|---|---|---|---|---|---|---|---|---|
| 18-Feb | 4-5 | A | 58 | 0 | 0 | 0 | 0 | 58 | 28 | Snowing |
| 23-Feb | 4-6 | B | 254 | 36 | 1 | 6 | 0 | 297 | 46 | Sunny |
| 24-Feb | 8-10 | B | 31 | 3 | 1 | 2 | 0 | 37 | 36 | Sunny |
| 24-Feb | 4-6 | A | 273 | 38 | 1 | 0 | 0 | 312 | 54 | Slight rain |
| 25-Feb | 8-10 | A | 88 | 2 | 0 | 0 | 1 | 91 | 28 | Sunny |
| 25-Feb | 4-6 | B | 159 | 38 | 0 | 2 | 4 | 203 | 43 | Sunny |
| 26-Feb | 8-10 | B | 26 | 9 | 0 | 1 | 0 | 36 | 30 | Cloudy |
| 26-Feb | 4-6 | A | 295 | 41 | 0 | 0 | 0 | 336 | 45 | Cloudy |
| 27-Feb | 8-10 | A | 263 | 22 | 0 | 8 | 0 | 293 | 43 | Drizzle, Cloudy |
| 27-Feb | 4-6 | B | 325 | 114 | 24 | 13 | 11 | 487 | 52 | Cloudy |
| 28-Feb | 8-10 | B | 22 | 1 | 0 | 0 | 0 | 23 | 48 | Rain |
| 28-Feb | 4-6 | A | 441 | 74 | 20 | 14 | 0 | 549 | 59 | Cloudy, Couple Drops |
| 1-Mar | 8-10 | A | 88 | 9 | 0 | 0 | 0 | 97 | 37 | Mostly Cloudy |
| 1-Mar | 4-6 | B | 136 | 20 | 0 | 7 | 0 | 163 | 43 | Mostly Cloudy |
| 2-Mar | 8-10 | B | 29 | 8 | 0 | 1 | 0 | 38 | 21 | Sunny |
| 2-Mar | 4-6 | A | 398 | 47 | 0 | 8 | 2 | 455 | 41 | Sunny |
| 3-Mar | 8-10 | A | 103 | 9 | 0 | 6 | 0 | 118 | 28 | Sunny |
| 3-Mar | 4-6 | B | 453 | 190 | 2 | 10 | 26 | 681 | 59 | Sunny |
| 4-Mar | 8-10 | B | 38 | 9 | 0 | 0 | 0 | 47 | 34 | Sunny |
| 4-Mar | 4-6 | A | 165 | 17 | 0 | 2 | 0 | 184 | 34 | Snow Flakes, Cloudy |
| 5-Mar | 8-10 | A | 102 | 3 | 0 | 0 | 0 | 105 | 21 | Sunny |
| 5-Mar | 4-6 | B | 161 | 40 | 0 | 4 | 8 | 213 | 41 | Sunny |
| 6-Mar | 8-10 | B | 139 | 9 | 0 | 3 | 0 | 151 | 28 | Sunny |
| 9-Mar | 4-6 | A | 898 | 285 | 0 | 40 | 11 | 1234 | 64 | Cloudy |
| 10-Mar | 8-10 | A | 160 | 25 | 0 | 2 | 1 | 188 | 45 | Sunny |
| 10-Mar | 4-6 | B | 351 | 161 | 9 | 12 | 17 | 550 | 68 | Cloudy |
| 11-Mar | 8-10 | B | 51 | 10 | 0 | 4 | 0 | 65 | 61 | Cloudy |
| 11-Mar | 4-6 | A | 268 | 36 | 0 | 16 | 0 | 320 | 61 | Rain |
| 12-Mar | 8-10 | A | 165 | 23 | 0 | 5 | 0 | 193 | 43 | Sunny |
| 12-Mar | 4-6 | B | 243 | 144 | 4 | 0 | 23 | 414 | 59 | Sunny |
| 13-Mar | 8-10 | B | 125 | 17 | 0 | 0 | 1 | 143 | 34 | Sunny |
| 13-Mar | 4-6 | A | 636 | 169 | 0 | 50 | 6 | 861 | 50 | Sunny |
| 14-Mar | 8-10 | A | 230 | 17 | 0 | 4 | 0 | 251 | 36 | Sunny |
| 14-Mar | 4-6 | B | 210 | 117 | 5 | 8 | 0 | 340 | 55 | Cloudy |
| 15-Mar | 8-10 | B | 18 | 5 | 0 | 1 | 0 | 24 | 27 | Cloudy |
| 15-Mar | 4-6 | A | 87 | 7 | 0 | 0 | 0 | 94 | 37 | Snow Mix |
| 16-Mar | 8-10 | A | 94 | 9 | 0 | 2 | 0 | 105 | 39 | Partly Cloudy |
| 16-Mar | 4-6 | B | 169 | 57 | 0 | 5 | 0 | 231 | 52 | Cloudy |
| 17-Mar | 8-10 | B | 26 | 14 | 0 | 4 | 0 | 44 | 41 | Cloudy |
| 17-Mar | 4-6 | A | 701 | 216 | 0 | 31 | 10 | 958 | 64 | Cloudy |
| 18-Mar | 8-10 | A | 19 | 1 | 0 | 0 | 0 | 20 | 52 | Rain |
| 18-Mar | 4-6 | B | 25 | 4 | 0 | 0 | 0 | 29 | 46 | Drizzle |
| 19-Mar | 8-10 | B | 36 | 10 | 0 | 2 | 0 | 48 | 32 | Sunny, Windy |
| 19-Mar | 4-6 | A | 404 | 71 | 0 | 13 | 3 | 491 | 48 | Sunny |